

# National Advisory Committee for Aeronautics

## Research Abstracts

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### CURRENT NACA REPORTS

NACA Rept. 1043

A NUMERICAL METHOD FOR THE STRESS ANALYSIS OF STIFFENED-SHELL STRUCTURES UNDER NONUNIFORM TEMPERATURE DISTRIBUTIONS. Richard R. Heldenfels. 1951. ii, 20p. diagrs., 9 tabs. (NACA Rept. 1043. Formerly TN 2241)

A numerical method is presented for the stress analysis of stiffened-shell structures of arbitrary cross section under nonuniform temperature distributions. The method is based on a previously published procedure that is extended to include temperature effects and multicell construction. The application of the method to practical problems is discussed and an illustrative analysis is presented of a two-cell box beam under the combined action of vertical loads and a nonuniform temperature distribution.

NACA Rept. 1044

THE METHOD OF CHARACTERISTICS FOR THE DETERMINATION OF SUPERSONIC FLOW OVER BODIES OF REVOLUTION AT SMALL ANGLES OF ATTACK. Antonio Ferri. 1951. ii, 16p. diagrs. (NACA Rept. 1044. Formerly TN 1809)

The method of characteristics has been applied to rotational supersonic flow around bodies of revolution at a small angle of attack. The practical numerical calculations are similar to those for zero angle of attack. A method for determining supersonic flow around circular cones at an angle of attack is also given.

NACA Rept. 1045

SUPERSONIC FLOW AROUND CIRCULAR CONES AT ANGLES OF ATTACK. Antonio Ferri. 1951. ii, 11p. diagrs. (NACA Rept. 1045. Formerly TN 2236)

The properties of conical flow without axial symmetry are analyzed. The flow around cones of circular cross section at small angles of attack is determined by correctly considering the effect of the entropy gradients in the flow.

NACA Rept. 1057

ANALYSIS OF THE EFFECTS OF BOUNDARY-LAYER CONTROL ON THE TAKE-OFF AND POWER-OFF LANDING PERFORMANCE CHARACTERISTICS OF A LIAISON TYPE OF AIRPLANE. Elmer A. Horton, Laurence K. Loftin, Jr., Stanley F. Racisz and John H. Quinn, Jr. 1951. ii, 31p. diagrs. (NACA Rept. 1057. Formerly TN 1597; TN 2143)

An investigation has been made to determine whether boundary-layer control by suction might reduce the minimum take-off and landing distance of a four-place or five-place airplane or a liaison type of airplane having a pay load of 1500 pounds and a flight duration of 5 hours. The aspect ratio was varied from 5 to 15, the wing span from 25 to 100 feet, and the brake horsepower from 300 to 1200. The effectiveness of boundary-layer control in reducing the total take-off distance for a given maximum speed improves with increasing aspect ratio and, for wing loadings of 10 pounds per square foot or more and an aspect ratio of 10 or more, the addition of boundary-layer control results in a decrease in the total take-off distance of as much as 14 percent. The use of boundary-layer control causes reduction in total landing distances (25 to 40 percent), ground-run distance, gliding speed, and stalling speed whereas sinking speed is increased only slightly.

NACA TN 2831

SPAN LOAD DISTRIBUTIONS RESULTING FROM CONSTANT ANGLE OF ATTACK, STEADY ROLLING VELOCITY, STEADY PITCHING VELOCITY, AND CONSTANT VERTICAL ACCELERATION FOR TAPERED SWEPTBACK WINGS WITH STREAMWISE TIPS. SUBSONIC LEADING EDGES AND SUPERSONIC TRAILING EDGES. Margery E. Hannah and Kenneth Margolis. December 1952. 221p. diagrs., 4 tabs. (NACA TN 2831)

On the basis of the linearized supersonic-flow theory the theoretical spanwise distributions of circulation (which are proportional to the span load distribution) resulting from constant angle of attack, steady rolling velocity, steady pitching velocity, and constant vertical acceleration were calculated for a series of thin, sweptback, tapered wings with streamwise tips, subsonic leading edges, and supersonic trailing edges. The results of the analysis are presented as a series of design charts. Some illustrative variations of the spanwise distributions of circulation with aspect ratio, taper ratio, Mach number, leading-edge sweepback, and axis-of-pitch location are also included.

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NACA TN 2833

AN ANALYSIS OF NORMAL ACCELERATIONS AND AIRSPEEDS OF ONE TYPE OF TWIN-ENGINE TRANSPORT AIRPLANE IN COMMERCIAL OPERATIONS OVER A NORTHERN TRANSCONTINENTAL ROUTE. Roy Stelner. November 1952. 23p. diagrs., 4 tabs. (NACA TN 2833)

Normal-acceleration and airspeed data obtained for one type of twin-engine transport airplane in commercial operations over a northern transcontinental route are analyzed to determine the gust and gust-load experiences of the airplane. The acceleration increments experienced equaled or exceeded the limit-gust-load factor, on the average, twice (once positive and once negative) in about  $7.5 \times 10^6$  flight miles, and an effective gust velocity of 30 feet per second was equaled or exceeded twice in about  $1 \times 10^6$  flight miles. The data indicate that the maximum gusts and gust loads experienced in the winter were roughly 10 percent higher than those experienced in the summer on this route.

NACA TN 2837

CORRECTIONS FOR DRAG, LIFT, AND MOMENT OF AN AXIALLY SYMMETRICAL BODY PLACED IN A SUPERSONIC TUNNEL HAVING A TWO-DIMENSIONAL PRESSURE GRADIENT.

I. J. Kolodner, F. Reiche and H. F. Ludloff, New York University. November 1952. 45p. (NACA TN 2837)

Corrections for drag, lift, and moment are derived for an axially symmetrical body placed in a supersonic tunnel having a two-dimensional pressure gradient. Although relatively simple longitudinal and transverse pressure gradients are assumed, the analytical treatment is rather difficult because of the difference in symmetry between the body and the basic flow field. Assuming irrotational conditions, the velocity potential of the flow around the body is expanded in powers of two parameters characterizing the body thickness and the inhomogeneity of the field and as a Fourier series in the azimuth around the body axis. Upon substitution of this potential series, the nonlinear equation of motion and the boundary condition on the body surface are split into a set of linearized boundary-value problems which can be solved analytically.

NACA TN 2840

BUCKLING OF LOW ARCHES OR CURVED BEAMS OF SMALL CURVATURE. Y. C. Fung and A. Kaplan, California Institute of Technology. November 1952. 75p. diagrs., photo., 9 tabs. (NACA TN 2840)

A general solution, based on the classical buckling criterion, is given for the problem of buckling of low arches under a lateral loading acting toward the center of curvature. For a sinusoidal arch under sinusoidal loading, the critical load can be expressed exactly as a simple function of the beam dimension parameters. For other arch shapes and load distributions, approximate values of the critical

load can be obtained by summing a few terms of a rapidly converging Fourier series. The effects of initial end thrust and axial and lateral elastic support are discussed. The buckling load based on the energy criterion of Kármán and Tsien is also calculated. Results for both the classical and the energy criteria are compared with experimental results.

NACA TN 2841

INVESTIGATION OF 75-MILLIMETER-BORE DEEP-GROOVE BALL BEARINGS UNDER RADIAL LOAD AT HIGH SPEEDS. I - OIL-FLOW STUDIES.

Zoltan N. Nemeth, E. Fred Macks and William J. Anderson. December 1952. 30p. diagrs., 2 tabs. (NACA TN 2841)

At an oil inlet temperature of  $100^{\circ}$  F, two methods of bearing lubrication, single jet and puddling, were investigated. In this investigation, 75-millimeter-bore ball bearings were studied over a range of DN values (bore times speed) from  $0.3 \times 10^6$  to  $1.2 \times 10^6$ , radial loads from 7 to 1113 pounds, and oil flows from 2 to 8 pounds per minute. The quantity of oil which flows through the bearing is shown to have an important effect on bearing operating temperatures and lubrication-system heat load. The effects of the operating variables on the oil flow through the bearing and upon the bearing outer- and inner-race temperatures are discussed.

NACA TN 2843

AUXILIARY EQUIPMENT AND TECHNIQUES FOR ADAPTING THE CONSTANT-TEMPERATURE HOT-WIRE ANEMOMETER TO SPECIFIC PROBLEMS IN AIR-FLOW MEASUREMENTS. James C. Laurence and L. Gene Landes. December 1952. ii, 77p. diagrs., photos., 3 tabs. (NACA TN 2843)

The constant-temperature hot-wire anemometer amplifier and accessories have been developed to provide an instrument with wide frequency response, good stability, and ease of operation. Auxiliary equipment has been developed to provide heating currents for large wires, to make average-square computations, and to make double-correlation coefficient measurements. Techniques are described for using this equipment to study periodic phenomena such as surge, rotating stall, and wake surveys in centrifugal- and axial-flow compressors. The application of the equipment to the study of non-periodic phenomena such as intensity, scale, and spectra of isotropic turbulence is also discussed. Heat-loss data for standardized tungsten wire probes show that no wire calibration is necessary if accuracies of  $\pm 5$  percent are sufficient.

NACA TN 2844

LAMINAR BOUNDARY LAYER ON CONE IN SUPERSONIC FLOW AT LARGE ANGLE OF ATTACK.

Franklin K. Moore. Appendix B: NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS. Lynn Albers. November 1952. 34p. diagrs. (NACA TN 2844)

The laminar boundary-layer flow about a cone at large angles of attack to a supersonic stream has been analyzed in the plane of symmetry. At the bottom of the cone, velocity profiles were obtained showing the expected tendency of the boundary layer to become thinner on the under side of the cone as the angle of attack is increased. At the top of the cone, the analysis failed to yield unique solutions, except for small angle of attack. Beyond a certain critical angle of attack, boundary-layer flow does not exist in the plane of symmetry, thus indicating separation.

NACA RM L52K10a

**PRELIMINARY RESULTS OF STABILITY CALCULATIONS FOR THE BENDING OF BOX BEAMS WITH LONGITUDINALLY STIFFENED COVERS CONNECTED BY POSTS.** Roger A. Anderson, Thomas W. Wilder, III and Aldie E. Johnson, Jr. December 1952. 17p. diagrs., tab. (NACA RM L52K10a)

The preliminary results of a computational program are presented which give numerical values of the stiffnesses required of posts and longitudinal stiffeners along the row of posts to achieve desired buckling-stress values in the covers of a box beam subjected to bending. The validity of a short-cut solution to the stability equation derived in NACA TN 2760 is also shown.

## BRITISH REPORTS

N-17757\*

Aeronautical Research Council (Gt. Brit.)  
**THE PATH OF A LIGHT FLUID WHEN RELEASED IN A HEAVIER FLUID WHICH IS ROTATING.** Geoffrey Taylor. August 28, 1950. 10p. diagrs., tab. (ARC 13,327; CF 144; FM 1471)

This report presents a discussion of a previous report, "Thermo-Centrifugal Convection in Combustion Chambers," by J. F. Alcock and W. D. Armstrong, in which an attempt was made to calculate how a fluid would move if released in a fluid of another density while the whole system was rotating at uniform angular velocity.

N-20107\*

Marine Aircraft Experimental Establishment (Gt. Brit.) **A NOTE ON THE DEVELOPMENT OF SENSITIVE PRESSURE OPERATED WATER CONTACTS FOR USE ON SEAPLANES.** R. Parker. July 1952. 10p. diagrs., photos., tab. (MAEE F/Res/224)

A pressure operated water contact has been developed, suitable for indicating the instants of take-off and touchdown for a seaplane hull. Flight tests have shown that the instrument is accurate in operation and sufficiently robust for normal flight test use.

N-20122\*

Royal Aircraft Establishment (Gt. Brit.) **NOTES ON THE PERFORMANCE OF CRYSTALLOY AND H. C. R. MAGNETIC MATERIALS IN TRANSDUCTOR CIRCUITS.** A. G. Milnes and D. E. Fielder. May 1952. 22p. diagrs. (RAE Tech. Note EL. 35)

Transductor behavior with Crystalloy and H. C. R. as the core materials is examined and the sensitivity is shown to increase with increase in the supply voltage. As a result of this examination, a design flux density of 12,000 to 13,000 gauss (peak) is recommended for H. C. R. and 10,000 to 11,000 gauss (peak) for Crystalloy. The transductor characteristics obtained with H. C. R. cores are superior to those for Crystalloy; but to conserve supplies of nickel-iron materials, the use of Crystalloy or equivalent materials is advised for output stage transductors in applications where the highest standards of performance are not required.

N-20124\*

Royal Aircraft Establishment (Gt. Brit.) **THE "NATURAL VIGNETTING" OF PHOTOGRAPHIC LENSES.** R. W. Fish. May 1952. 10p. diagrs. (RAE Tech. Note Ph. 466)

The variation of illumination in the focal plane of a photographic lens is commonly represented by the  $\cos^4\theta$  law ("natural vignetting") in the absence of true vignetting, reflection and absorption losses, and veiling glare. It is shown that this  $\cos^4\theta$  law only holds when the image is free from distortion and there is no aberration of the entrance pupil. The collimator method of measuring the variation of illumination is shown to be correct in theory. The application to wide angle lenses for air survey is briefly discussed.

N-20125\*

Royal Aircraft Establishment (Gt. Brit.) **A PHOTO-ELECTRIC CURVE FOLLOWER.** R. H. Forrest and K. H. Treweek. With appendices. J. A. Roberts. May 1952. 61p. diagrs., photos. (RAE Tech. Note Arm. 487)

This curve follower reproduces in voltage form the ordinate of a curve recorded photographically as an opaque trace on clear film. A prototype instrument has been constructed and is described in some detail in the present paper. It is capable of following curves, recorded on 35-mm film, which do not exceed 80° in slope nor 20-mm peak to peak in amplitude at 60 cycles per second. The film is drawn past the face of a cathode ray tube in the X-axis direction and is viewed by a photocell which controls the Y-plate voltage to keep the luminous spot locked to the trace. The Y-plate voltage is therefore a measure of the curve ordinate. The follower works as a carrier frequency system and reads substantially the center of the recorded trace. The reading is therefore insensitive to line thickness and density,



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and the reading error in the prototype is about 2 percent of full scale. The appendices describe the theory of the generation of the signals by the optical system and the use of a galvanometer in place of a cathode ray tube.

N-20129\*

Royal Aircraft Establishment (Gt. Brit.)  
THE MEASUREMENT OF HEAT TRANSFER AND SKIN FRICTION AT SUPERSONIC SPEEDS. PART IV - TESTS ON A FLAT PLATE AT  $M = 2.82$ . R. J. Monaghan and J. R. Cooke. June 1952. 43p. diagrs., 3 tabs. (RAE Tech. Note Aero 2171)

This note gives the results of over-all heat transfer and boundary-layer measurements made on a flat plate in a 5-in. square supersonic wind tunnel operating at  $M = 2.82$  under atmospheric stagnation pressure conditions. The tests were made to extend the range of results previously obtained at  $M = 2.43^1, 2$  and used the same experimental equipment. In general, the results confirm those obtained at the lower Mach number and some general conclusions are now drawn concerning the structure and behavior of experimental laminar and turbulent compressible boundary layers on a flat plate. The present series of tests is now complete, but subsonic check tests remain to be made.

considered structure has essentially the properties of an orthotropic plate of variable thickness and differs from the usual aircraft wing design mainly by the assumption of a continuous and rigid system of ribs and webs, represented by the core. The relation between load and elastic deformation of such a flat structure is developed, starting from the theory of solid plates. Analysis yields a partial differential equation of fourth order with variable coefficients as an extension of the biharmonic equation for the deformation of solid plates of uniform thickness. By suppressing the rib bending, the said differential equation is linearized and a numerical computing becomes possible. Hence, a theory of a two dimensional flat structure can be developed, as an extension of the bending and twisting theory of the simple, one-dimensional beam.

## MISCELLANEOUS

NACA TN 2598

Errata No. 1 on "A TECHNIQUE APPLICABLE TO THE AERODYNAMIC DESIGN OF INDUCER-TYPE MULTISTAGE AXIAL-FLOW COMPRESSORS". Melvyn Savage and Loren A. Beatty. March 1952.

## UNPUBLISHED PAPERS

N-12952\*

ON THE STATICS OF THIN AIRCRAFT WINGS. (Zur Statik von dünnen Flugzeug-Tragflächen). H. Schürch. October 1952. 85p. diagrs., photo., 2 tabs. (Trans. from Eidgenössische Technische Hochschule Zurich. Institut für Flugzeugstatik und Flugzeugbau. Mitteilungen 2, 1950, 62p.).

This paper deals with the structural analysis of flat structures, similar to those encountered in the wing and tail-plane design of modern aircraft. A sandwich type flat structure is considered. This structure is assumed to be built up of two faces, carrying normal and shearing loads and of a core of pure shearing rigidity normal to its center plane. The faces are assumed to be stiffened by an orthogonal system of stringers. Due to the stringers, the local bending rigidity of the flat structure is variable in different surface directions. An arbitrary variation of these bending rigidities is taken into account. Thus, the